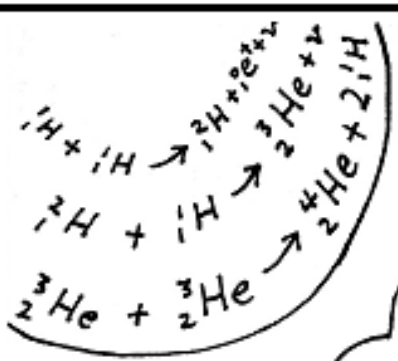


Nature's benefits to people: National & provincial significance of the Eastern Slopes

Dr. Aerin Jacob, Y2Y
24 June 2021





$$\nabla \cdot \mathbf{E} = \frac{1}{\epsilon_0} \rho$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = 0$$

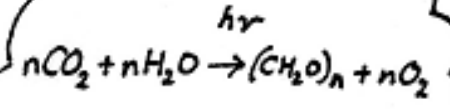
$$F = G \frac{m_1 m_2}{r^2}$$

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = 8\pi G T_{\mu\nu}$$

$$\frac{\partial}{\partial t} \left(\frac{\partial \mathbf{u}}{\partial x} \right) = \mu_0 \mathbf{J}$$

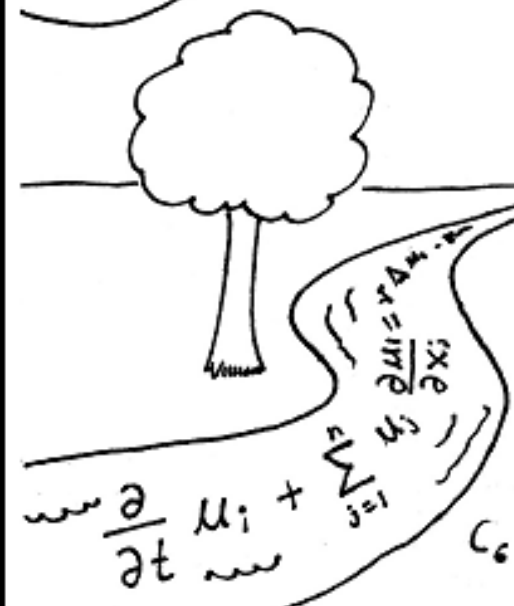
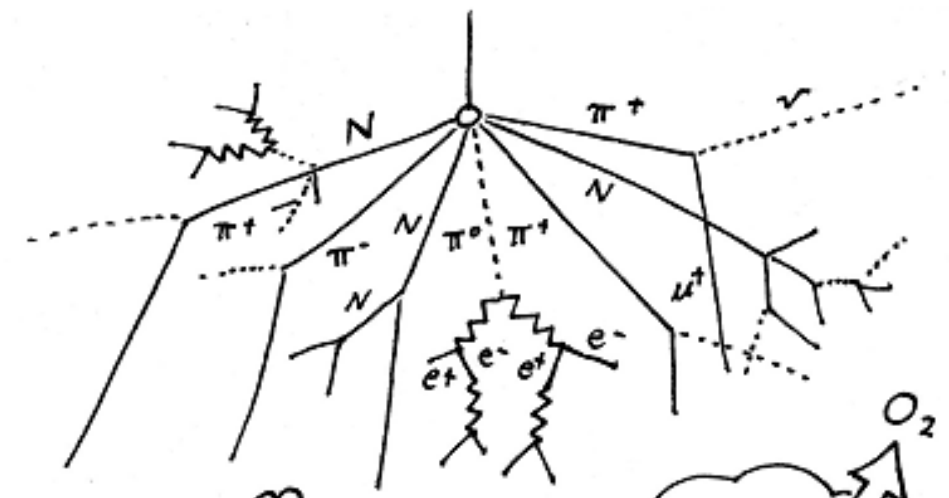
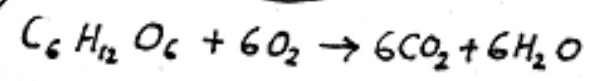
$$f(x) = a_0 + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx)$$

$$P + \frac{1}{2} \rho v^2 + \rho gh = C$$



$$\left[\frac{-\hbar^2}{2m} \nabla^2 + V \right] \psi = i\hbar \frac{\partial}{\partial t} \psi$$

$$\begin{aligned}
 \mathbf{x}_1(x,y) &= \begin{bmatrix} 0.85 & 0.04 \\ -0.04 & 0.85 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \\
 \mathbf{x}_2(x,y) &= \begin{bmatrix} -0.15 & 0.26 \\ 0.26 & -0.15 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} 0.15 \\ 0.26 \end{bmatrix}
 \end{aligned}$$



金吉時

People get all kinds of *benefits from nature*
("ecosystem services")



Model and map three key benefits that people get from nature across Canada (and Alberta)



Carbon
storage



Freshwater



Nature
Recreation



THE UNIVERSITY
OF BRITISH COLUMBIA



Carleton
UNIVERSITY



McGill
UNIVERSITY



Yellowstone to Yukon
Conservation Initiative



NATURE
CONSERVANCY
CANADA



WCSCanada



Mitchell et al. (2021) *Environmental Research Letters*.



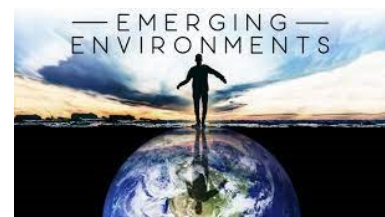
Pathway to Canada Target 1
En route vers l'objectif 1 du Canada



THE CITY OF
CALGARY



wildsight



Environment and
Climate Change Canada
Environnement et
Changement climatique Canada



Ecosystem Service Provision in the Canadian
Yellowstone-to-Yukon Region

Matthew Mitchell, PhD

December, 2019

1

Mitchell (2019) Technical report
for Y2Y about BC, AB, YT, & NWT.



Environment and
Climate Change Canada
Environnement et
Changement climatique Canada



THE CONVERSATION



Pathway to Canada Target 1
En route vers l'objectif 1 du Canada



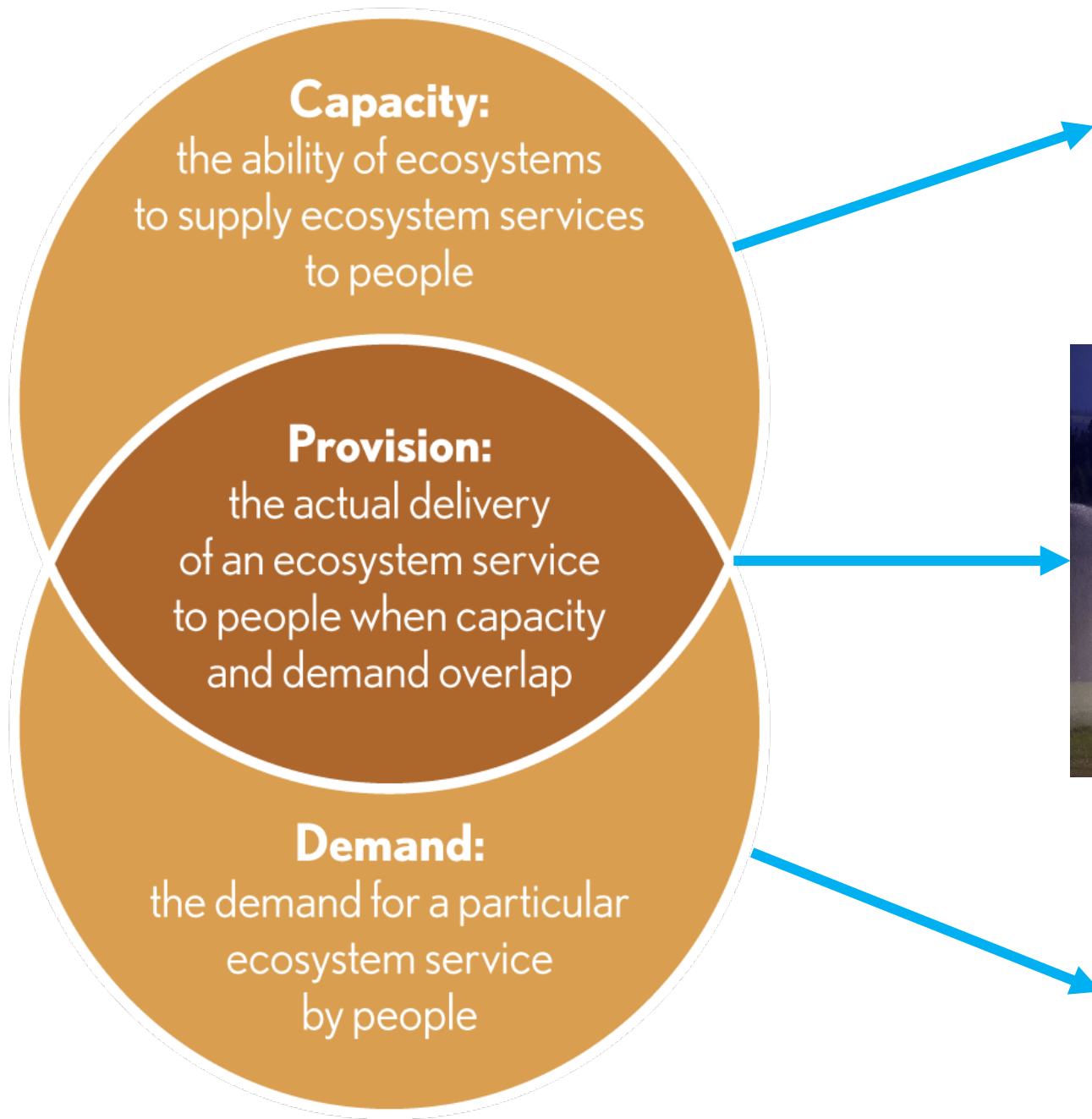
THE CITY OF
CALGARY



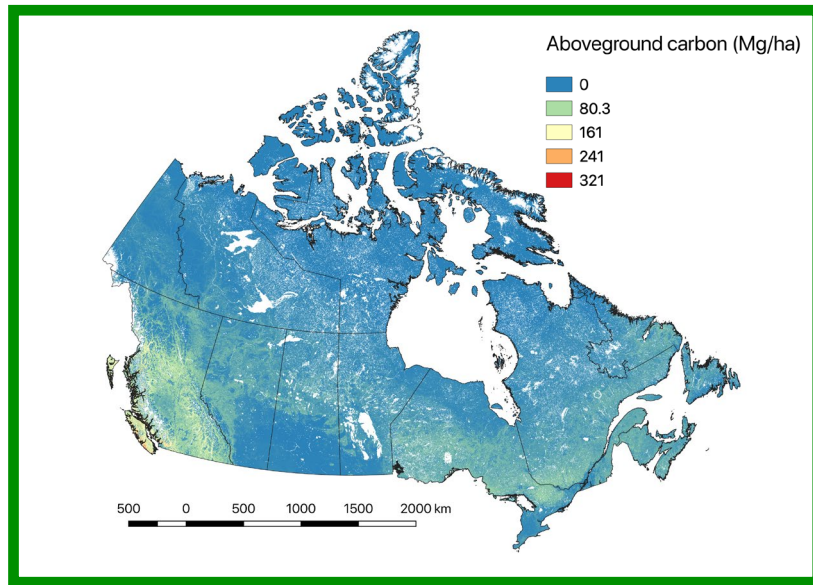
wildsight



FIRST NATIONS
LAND MANAGEMENT
RESOURCE CENTRE



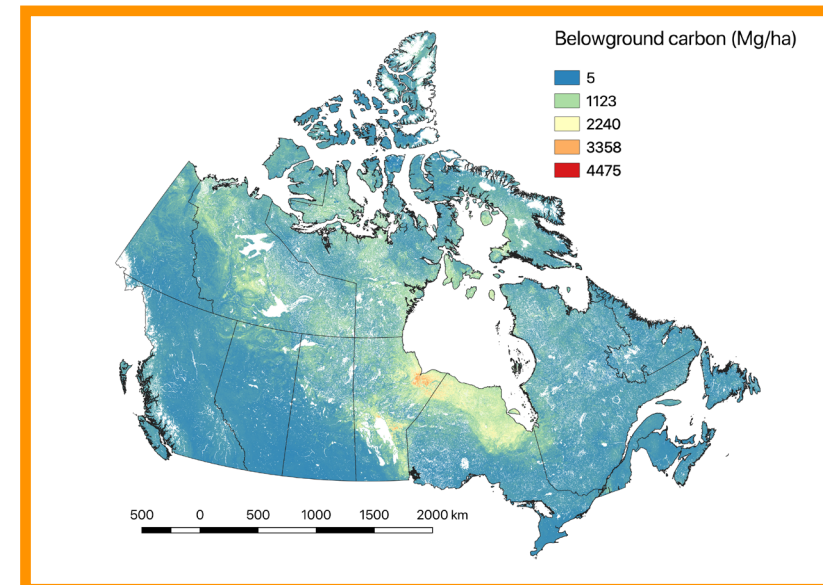
CARBON: ABOVEGROUND + BELOWGROUND = PROVISION



Aboveground carbon

- National Forest Inventory
- Live and dead tree biomass

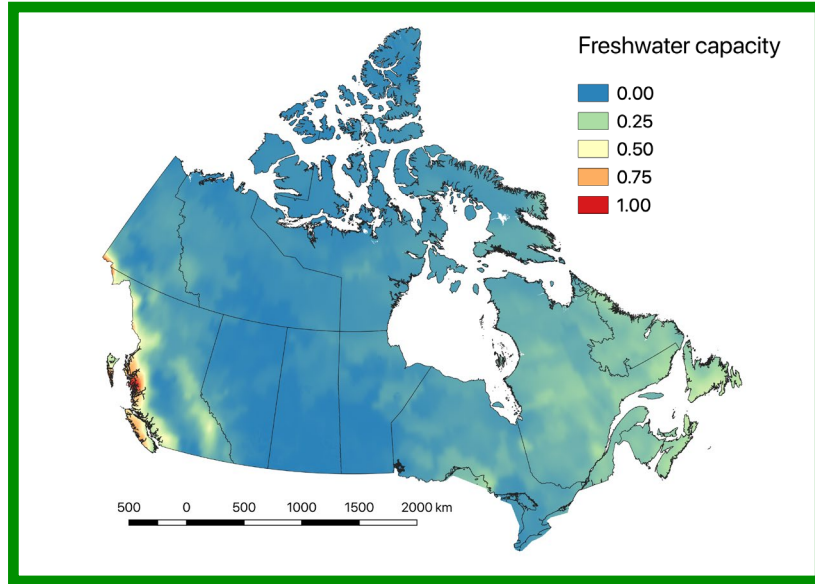
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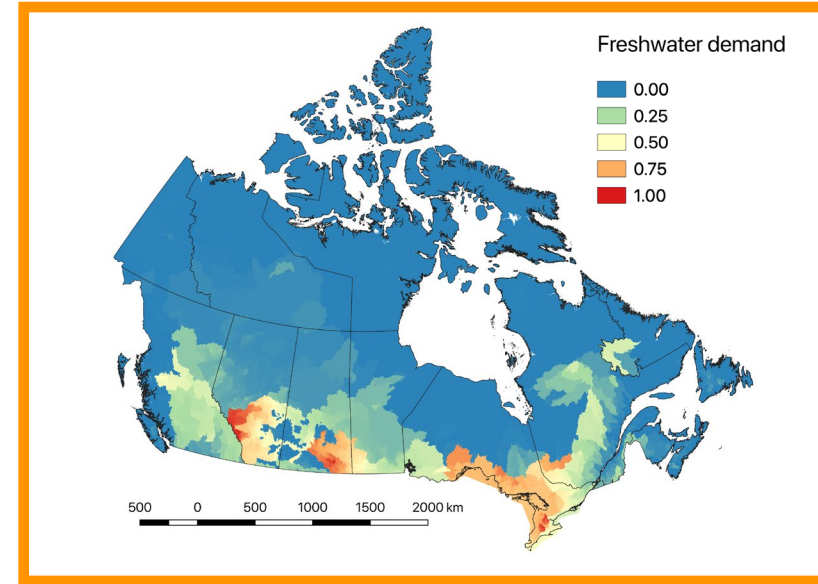
Belowground carbon

- SoilGRIDS data (0-1 m deep)
- Modelled from soil sample data

FRESHWATER: CAPACITY × DEMAND = PROVISION



X



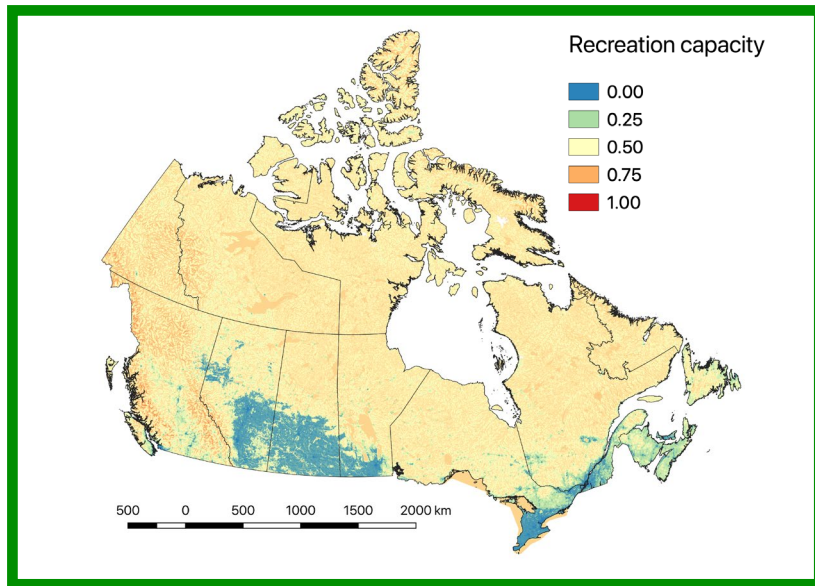
Freshwater capacity

- Estimated water runoff
- HydroSHEDS data
- Estimated from WaterGAP model

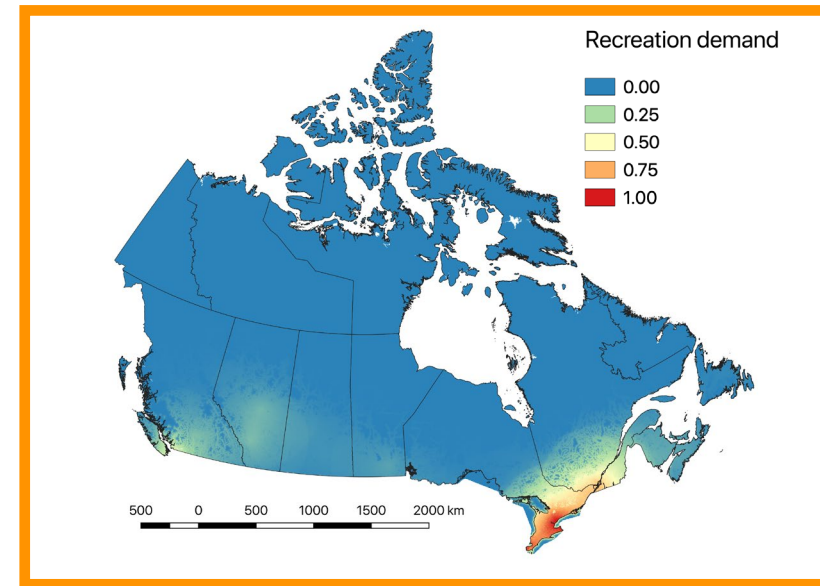
Freshwater demand

- Relative downstream demand
 - area of agricultural land
 - # of dams
 - # of settlements > 100 people
 - # industrial facilities & thermal power stations

RECREATION: $\text{CAPACITY} \times \text{ACCESS/DEMAND} = \text{PROVISION}$



X



Nature-based recreation capacity

Positive

- Land cover naturalness
- Proximity to water
- Mountains/ruggedness

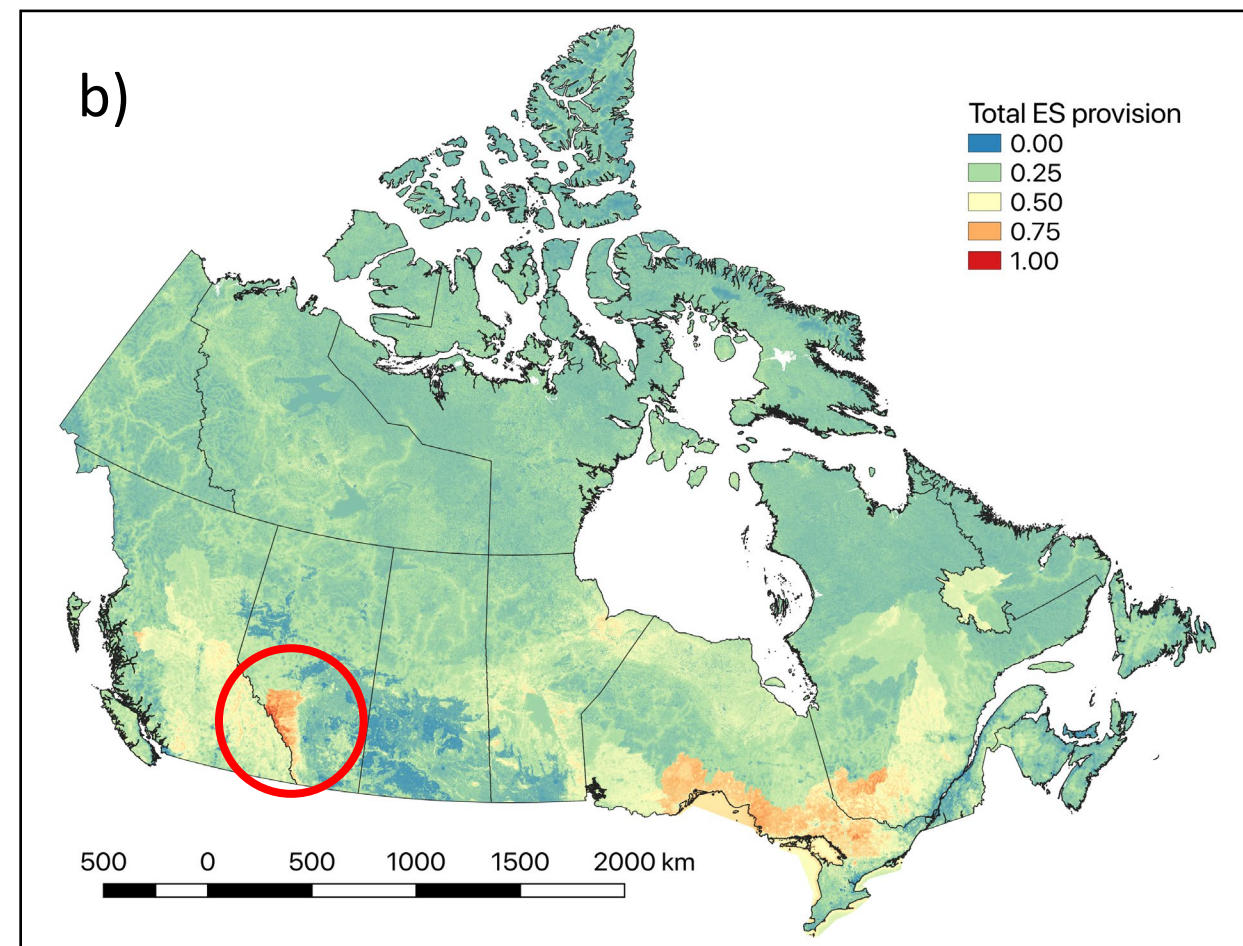
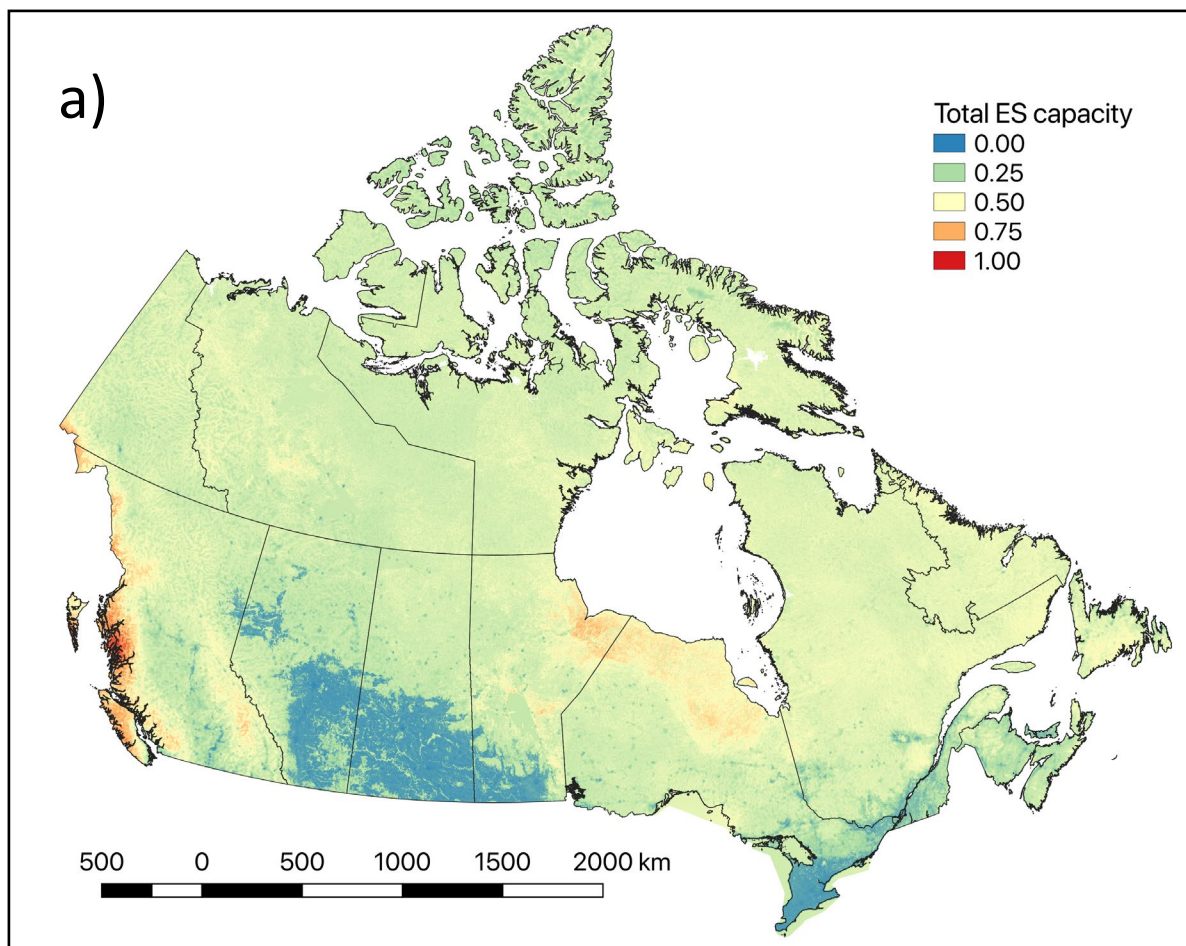
Negative

- Road density
- Population density

Nature-based recreation access/demand

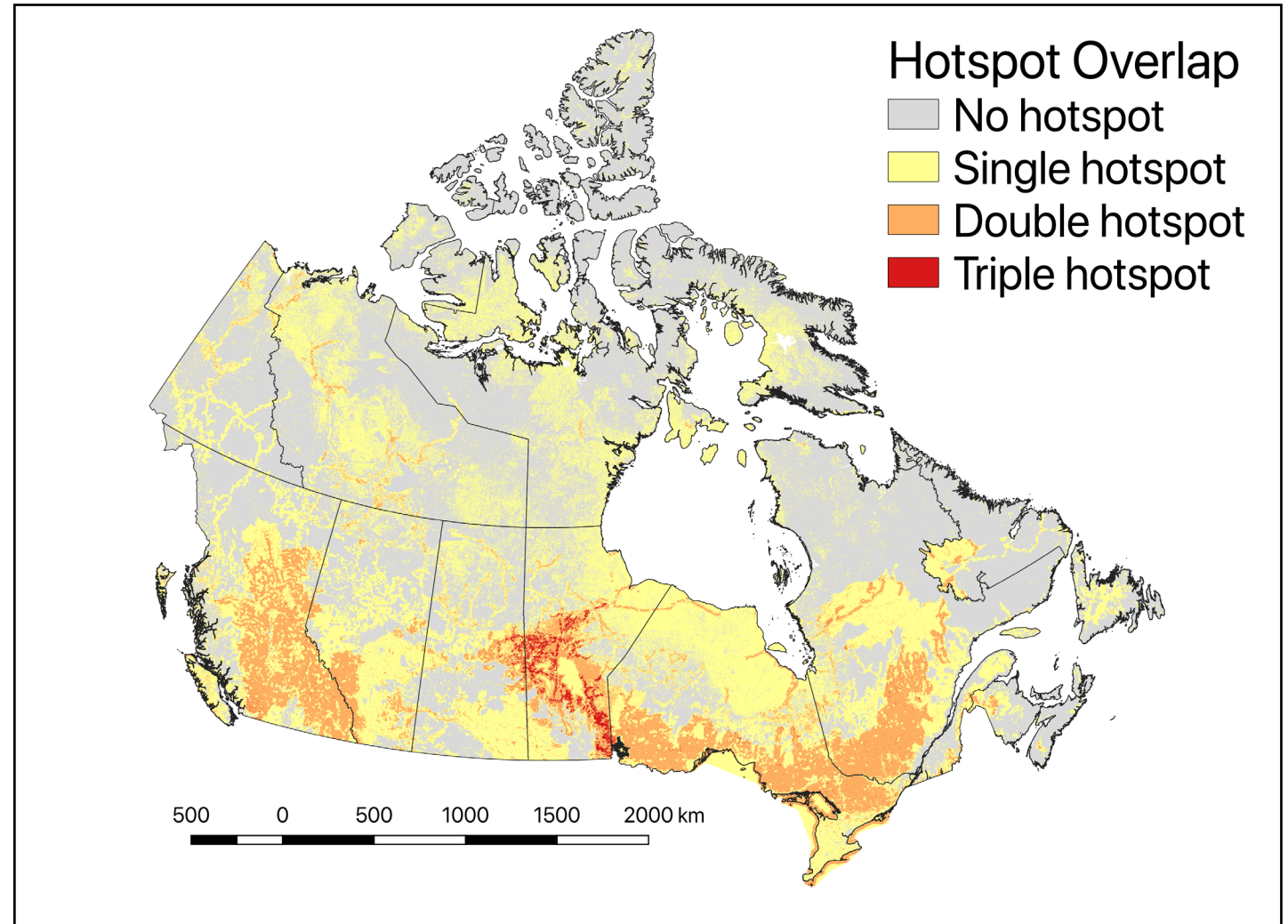
- Distance to road within 5 km
- Population density within 500 km (including US populations)

1 Where ecosystems a) can provide benefits are often not the same places where they b) actually do provide benefits to the most people



2 Most of the places where people get a lot of one benefit (“hotspot” = top 20% of one benefit) do not overlap with each other.

Places that are **orange** or **red** are really important → high amounts of 2 or 3 key benefits to people.



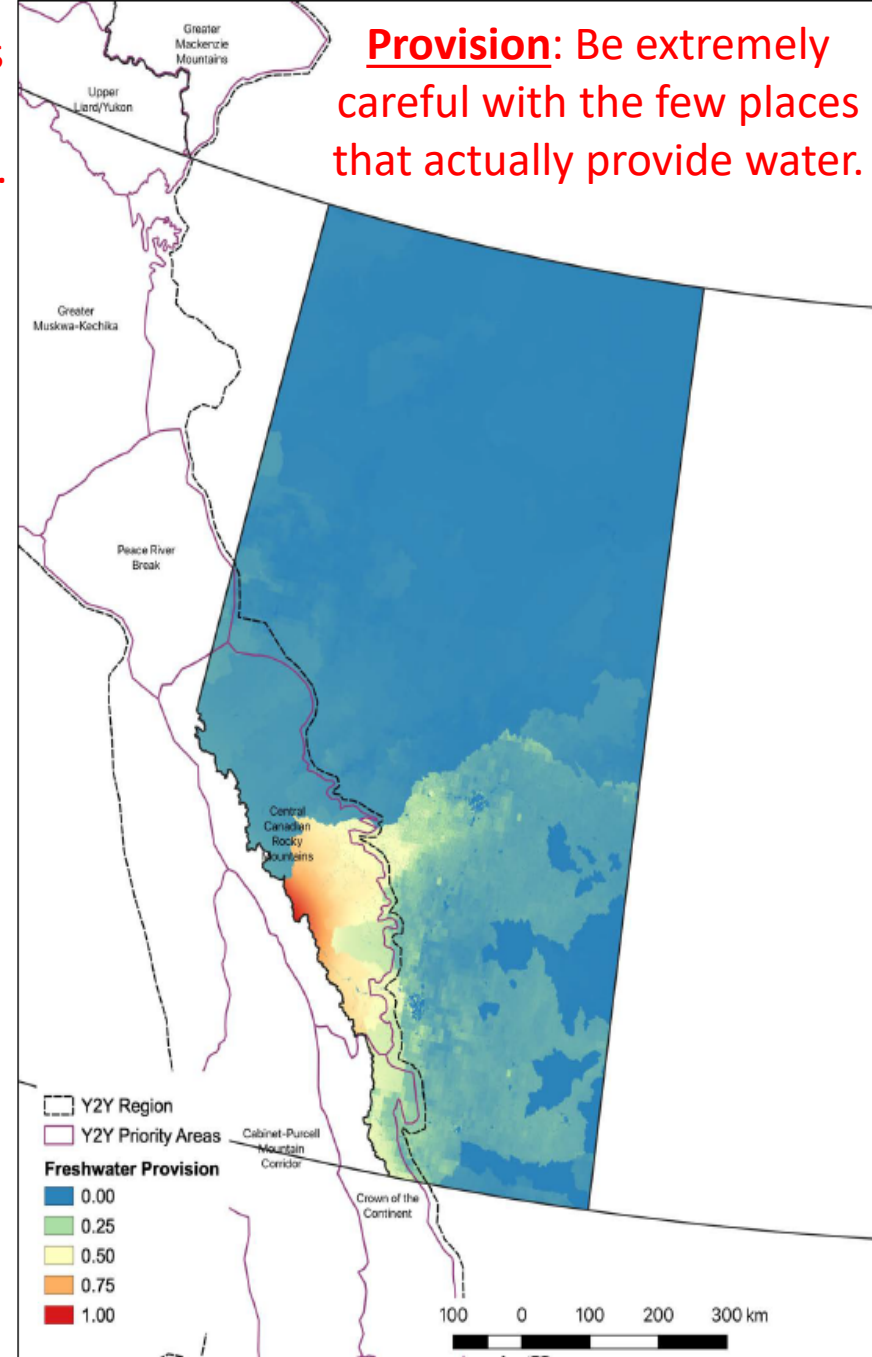
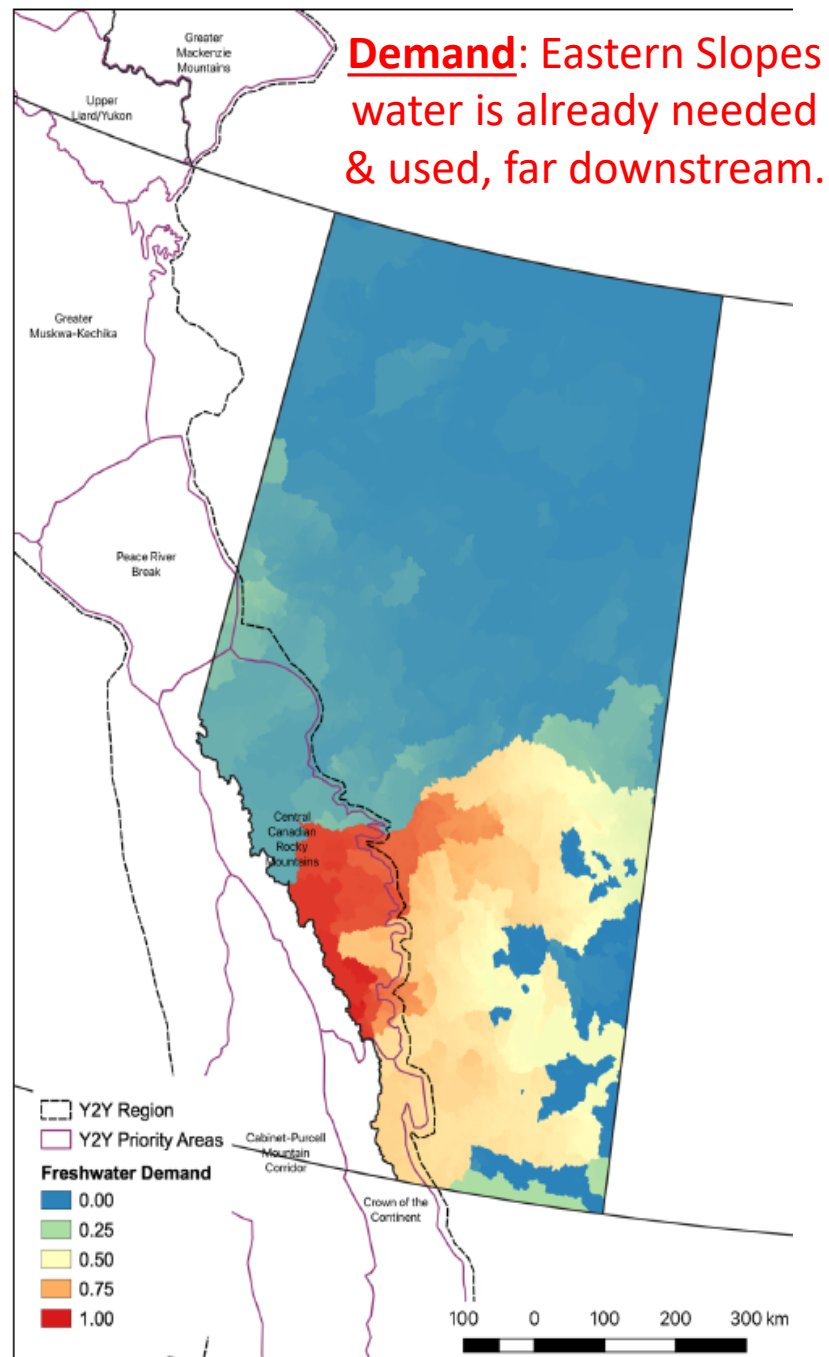
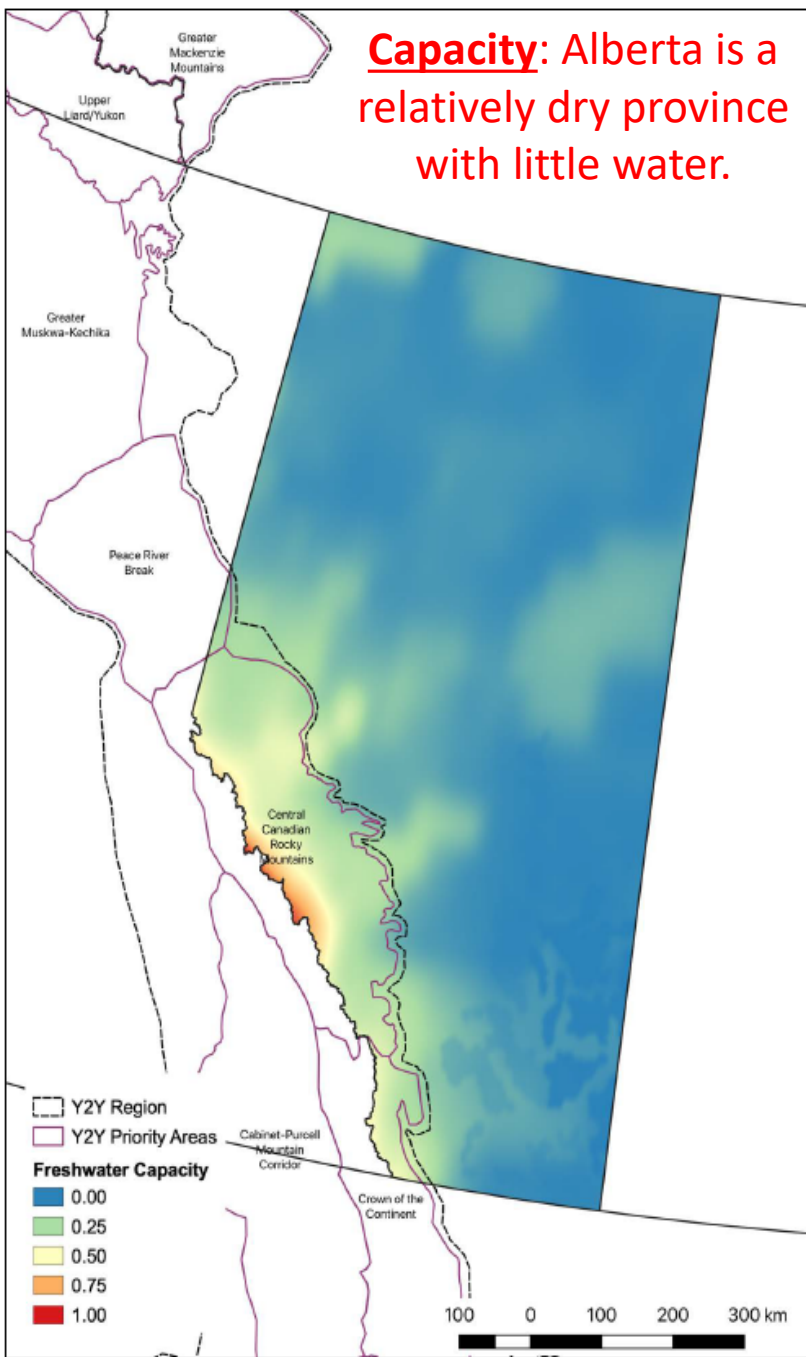


Figure 24. Freshwater capacity importance in Alberta.

Figure 25. Freshwater demand importance in Alberta.

Figure 26. Freshwater provision importance in Alberta.

Across all of Alberta, the most important places for the provision of freshwater to the most people is the Eastern Slopes.

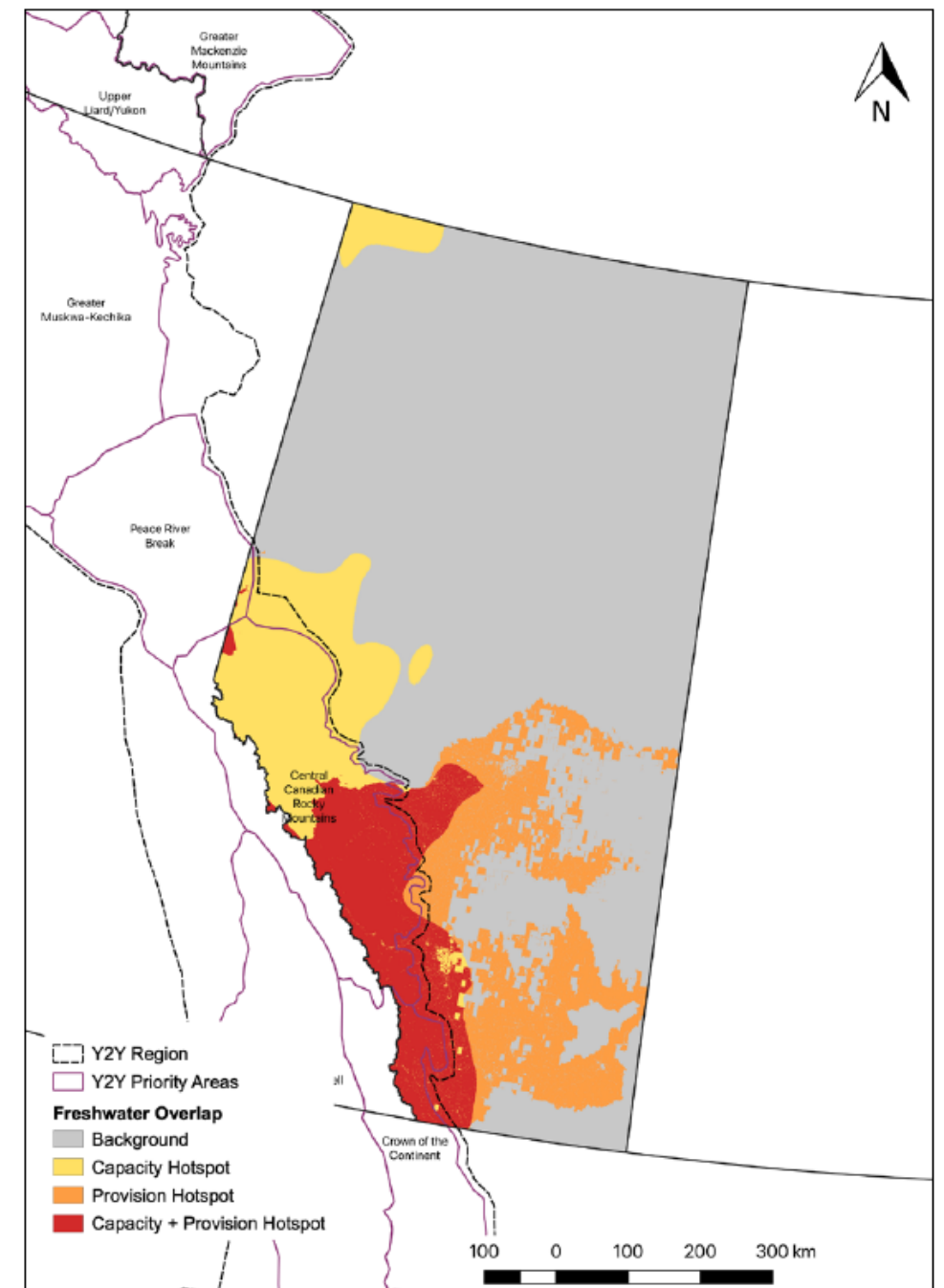


Figure 27. Freshwater provision hotspots (top 20th percentile of values) and overlap in Alberta.

Carbon + water +
recreation (**capacity**):
Eastern slopes have
high combined supply.

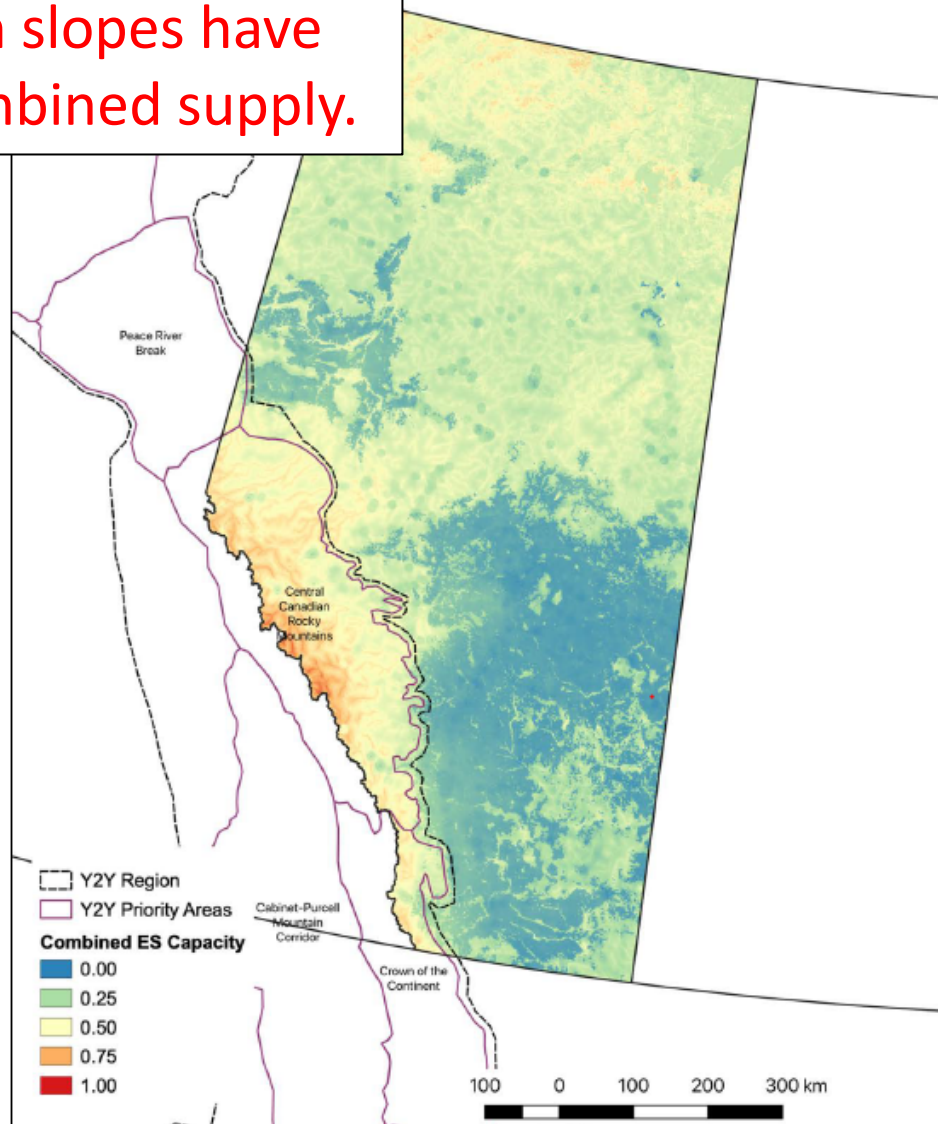


Figure 62. Combined ecosystem service capacity importance in Alberta.

Carbon + water + recreation
(**provision**): Eastern Slopes
are where people actually
get multiple benefits.

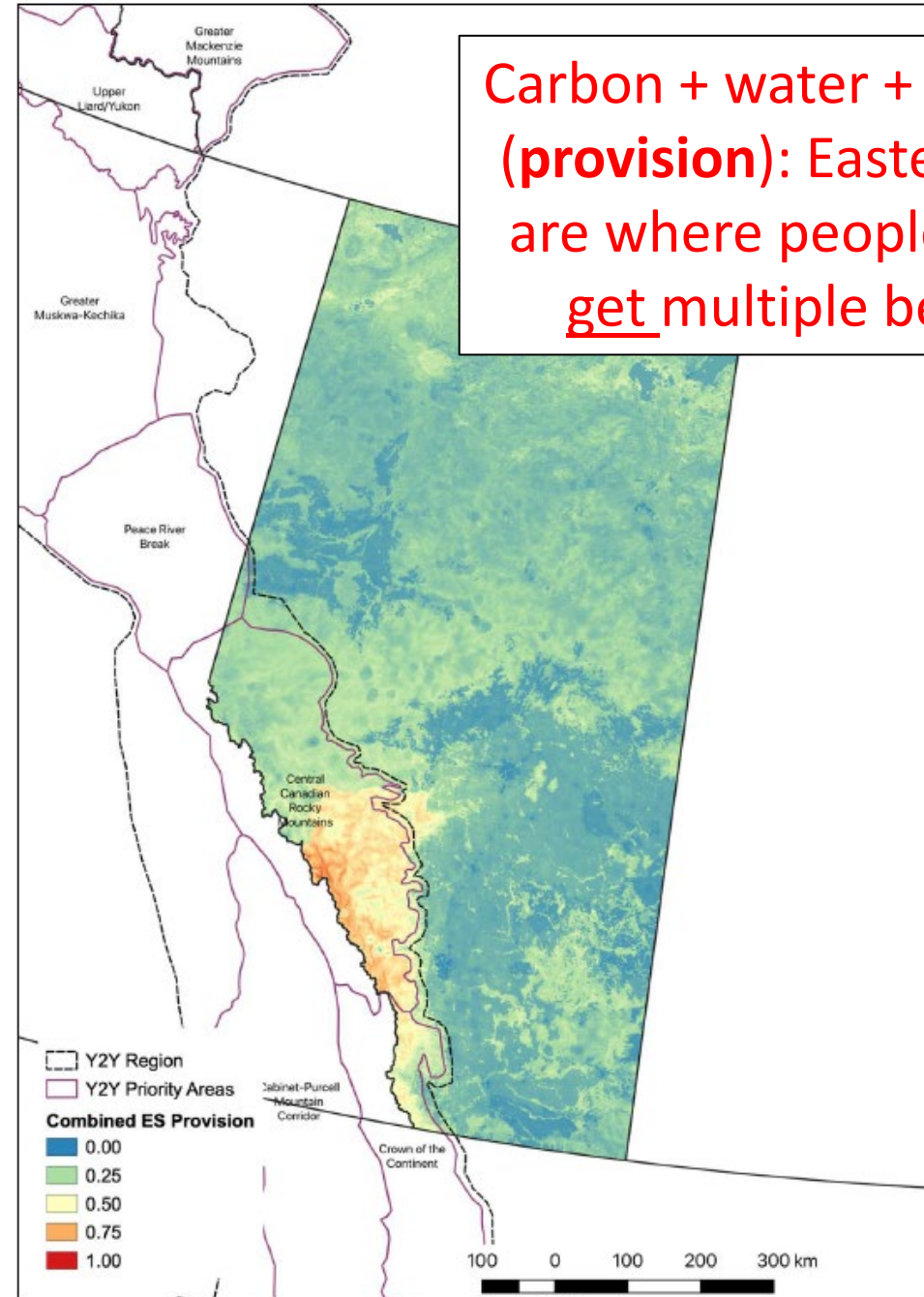


Figure 63. Combined ecosystem service provision importance in Alberta.

Across all of Alberta, the **most important** places for the combined provision of carbon storage, freshwater, and recreation to people is the Eastern Slopes.

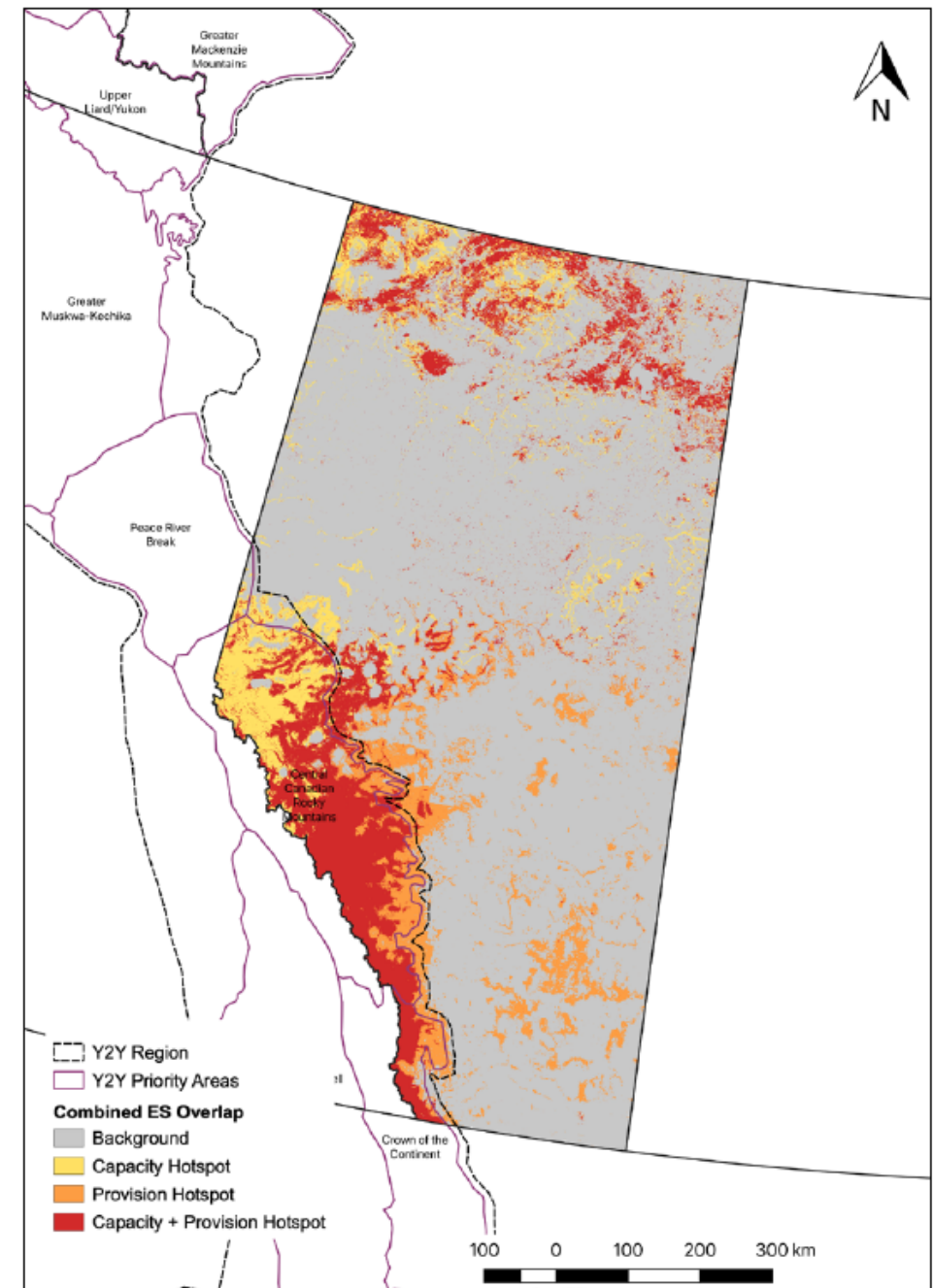
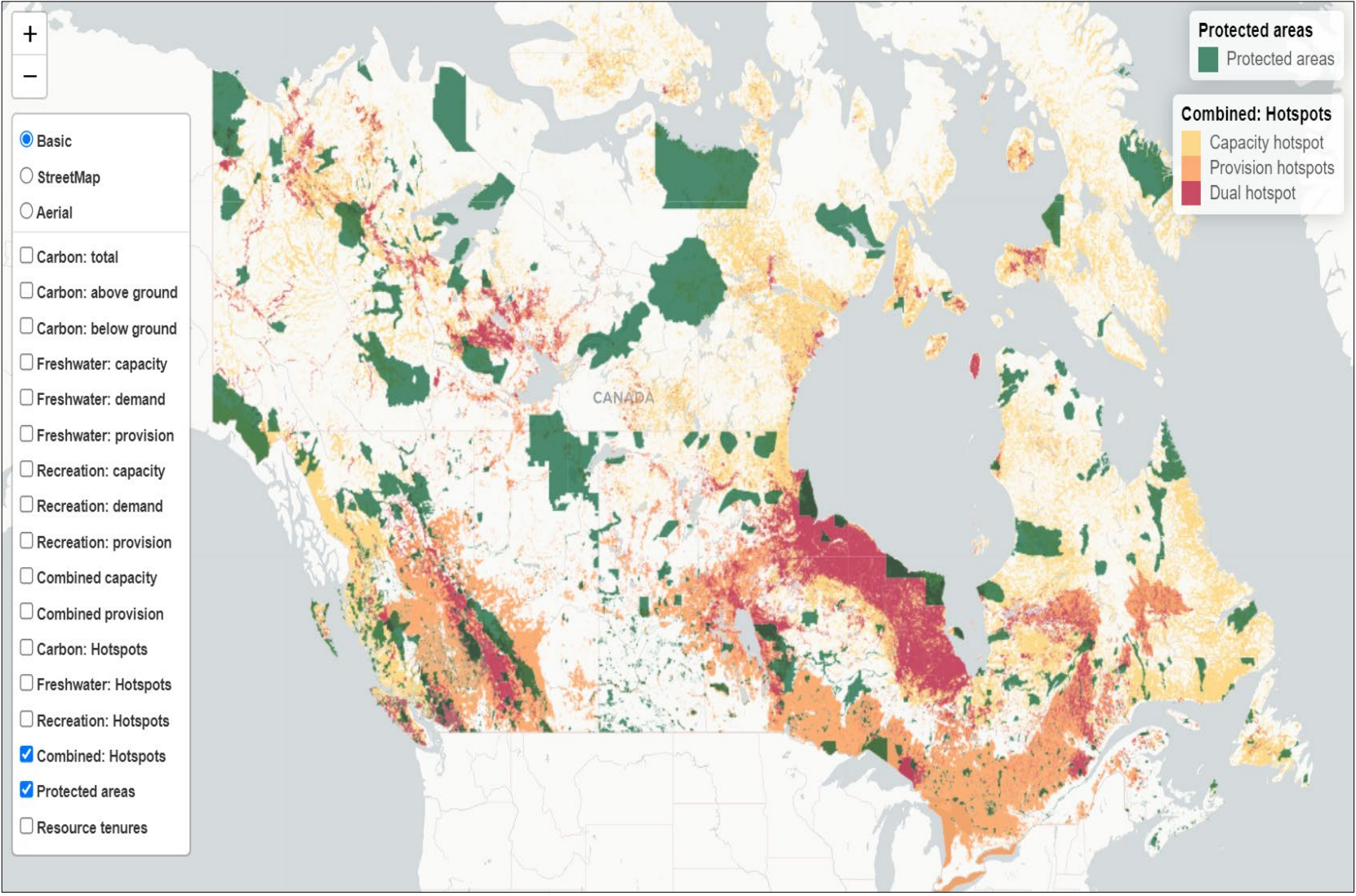


Figure 64. Combined ecosystem service provision hotspots (top 20th percentile of values) and overlap in Alberta.

EXTRA SLIDES

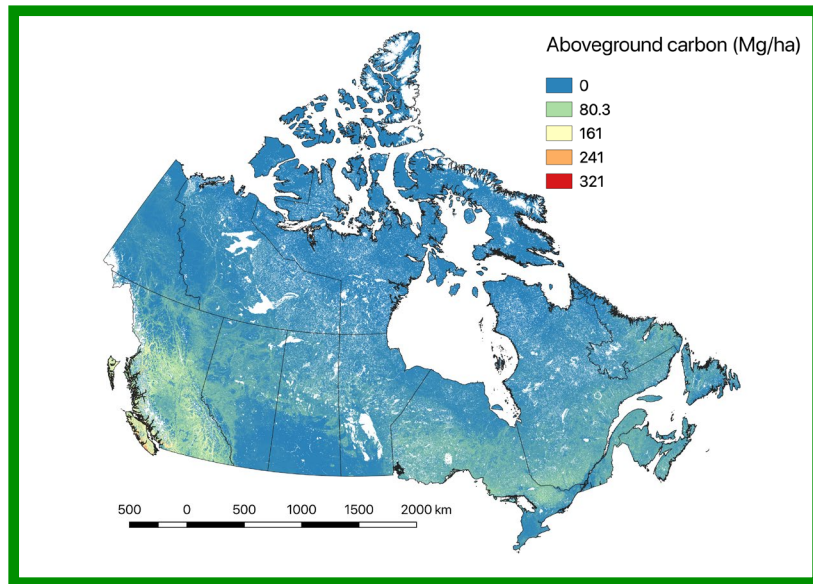
(about methods, if needed)



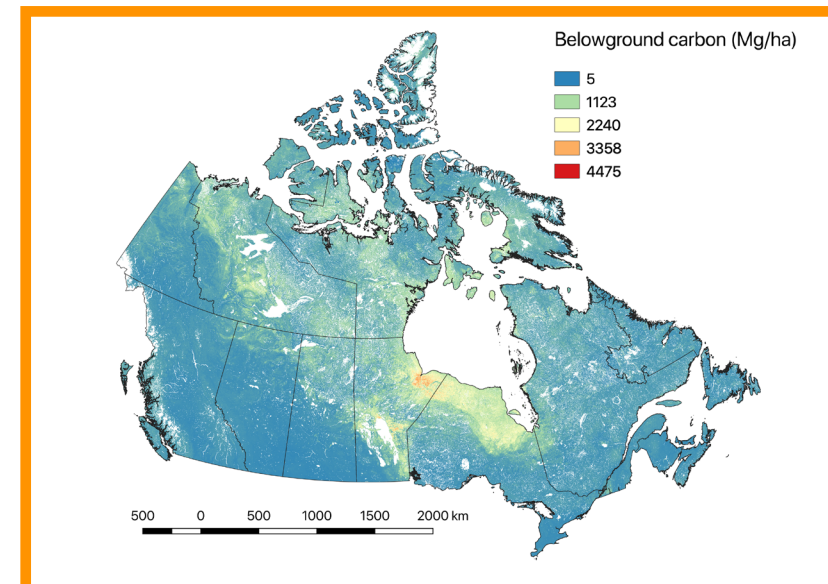
Mitchell et al. (2021)
Environmental Research Letters

Interactive data visualization
https://cons.carleton.ca/ES_CAN/

CARBON: ABOVEGROUND + BELOWGROUND = PROVISION



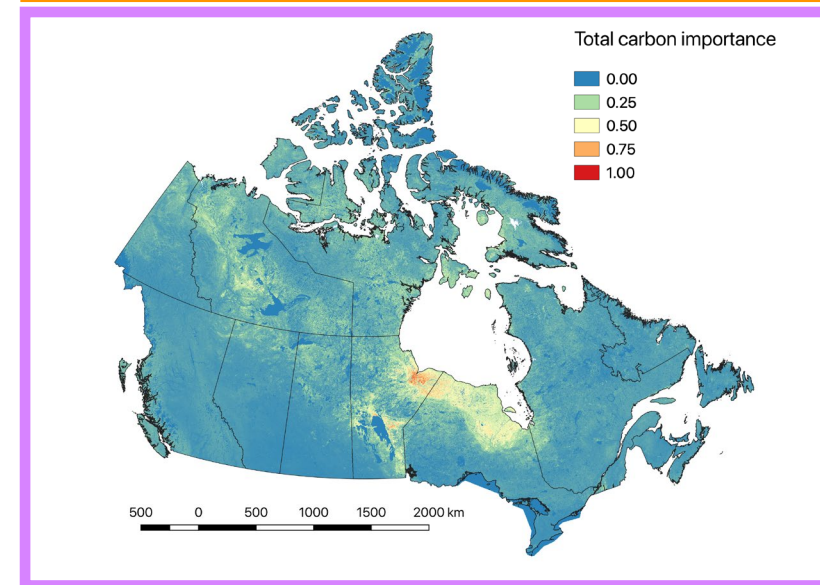
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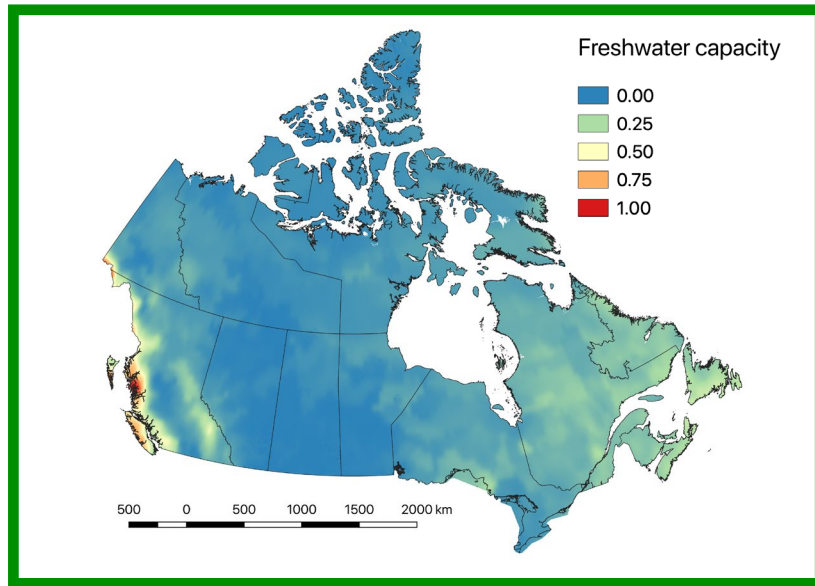
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Provision

- Aboveground + Belowground
- No need to include demand or flow



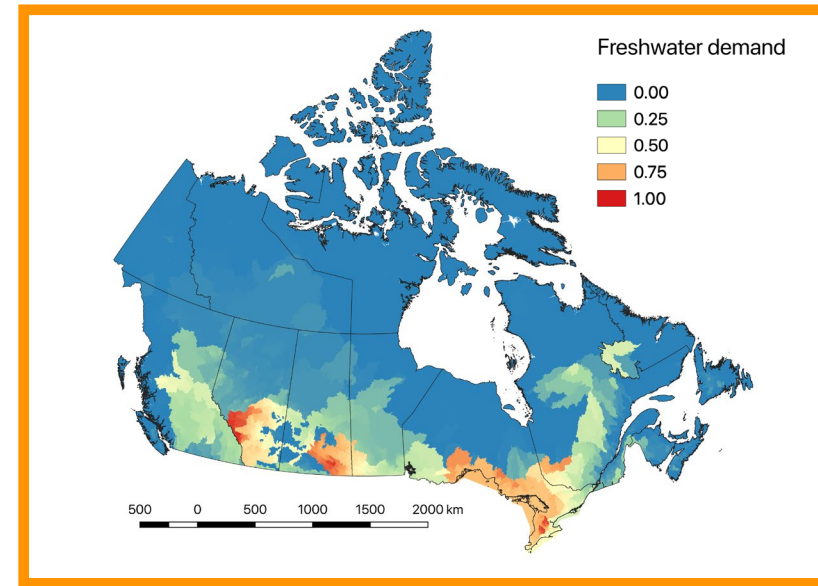
WATER: CAPACITY × DEMAND = PROVISION



Freshwater capacity

- Estimated water runoff
- HydroSHEDS data
- Estimated from WaterGAP hydrological model

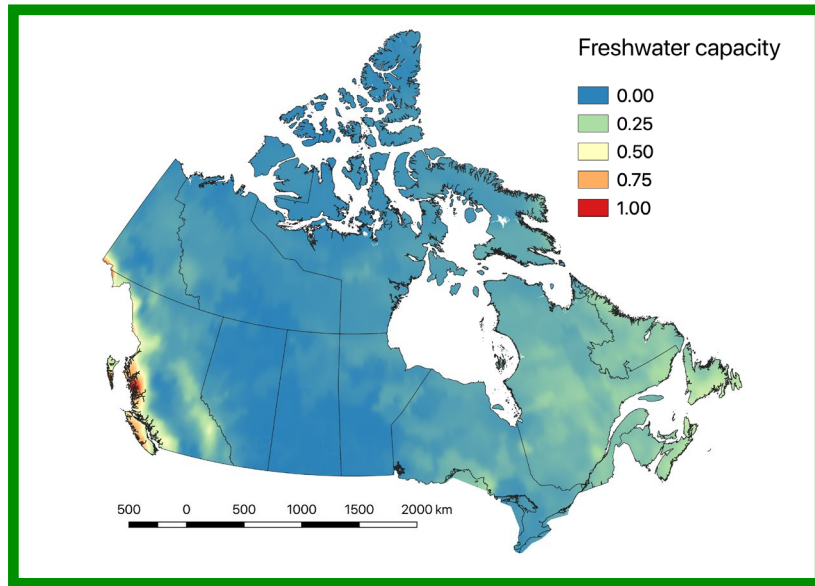
X



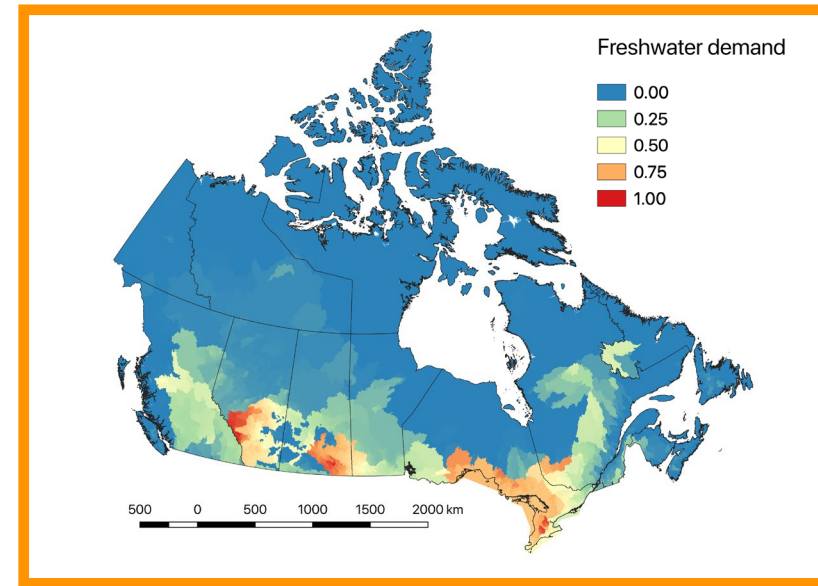
Freshwater demand

- Relative downstream demand
 - area of agricultural land
 - # of dams
 - # of settlements > 100 people
 - # industrial facilities and thermal power stations

WATER: CAPACITY × DEMAND = PROVISION



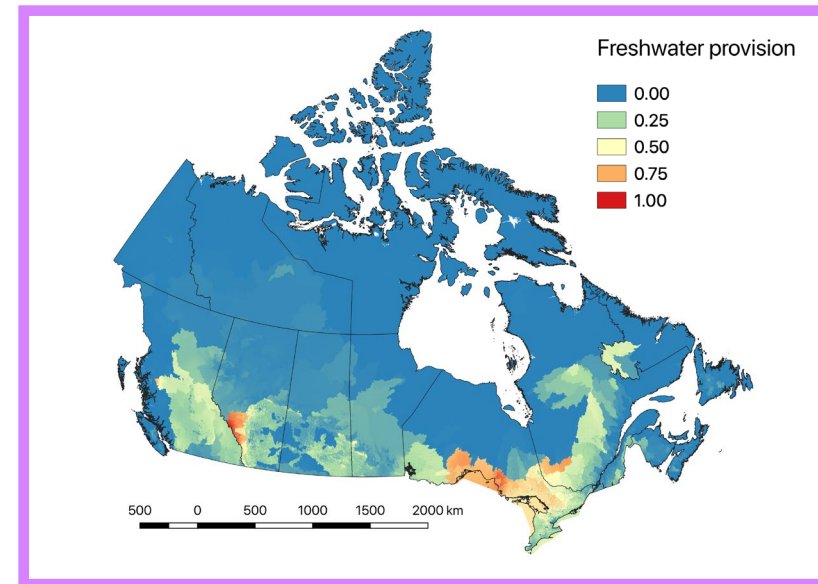
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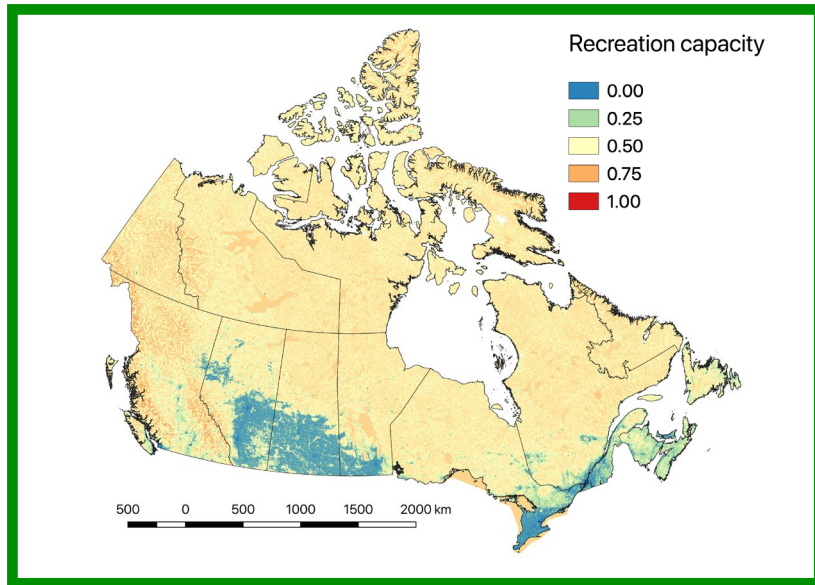
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Freshwater provision

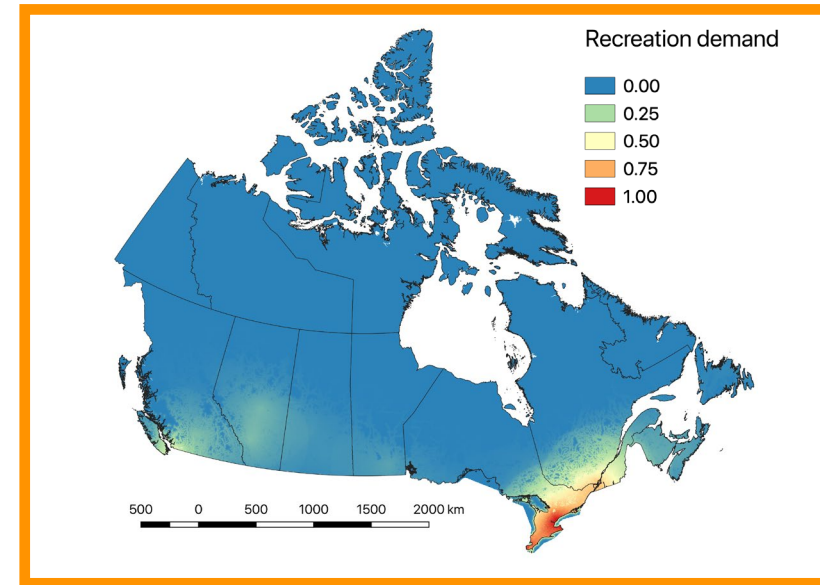
- Combination of capacity and demand
- Reduced for urban & agricultural areas
- Weighted towards water demand



RECREATION: $\text{CAPACITY} \times \text{ACCESS} = \text{PROVISION}$



X



Nature-based recreation capacity

Positive

- Land cover naturalness
- Proximity to water
- Mountains/ruggedness

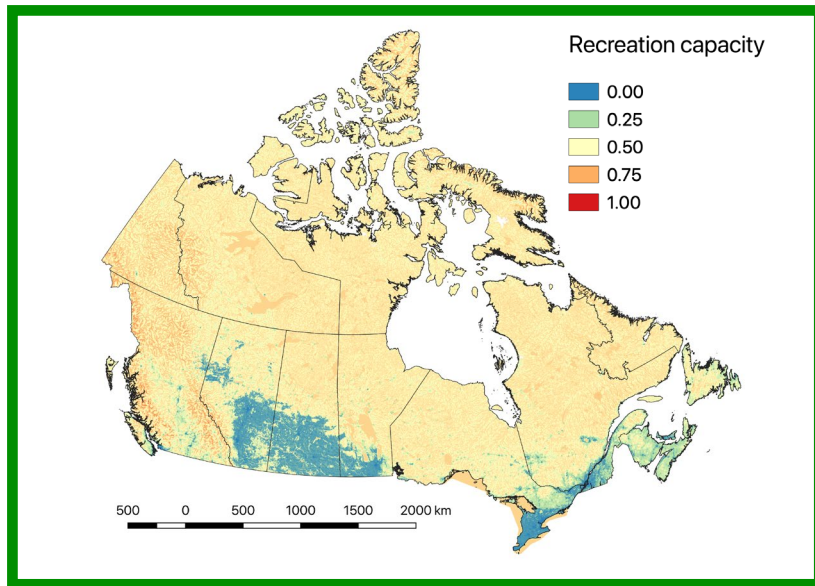
Negative

- Road density
- Population density

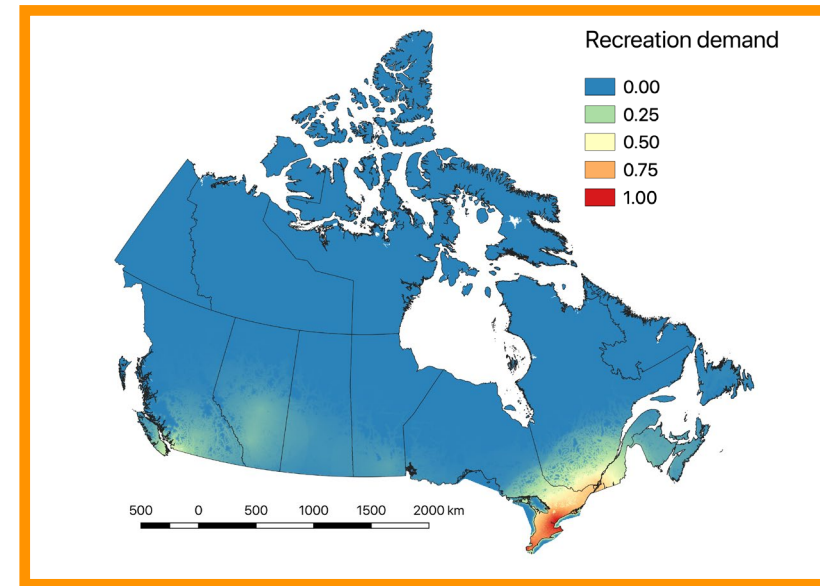
Nature-based recreation access/demand

- Distance to road within 5 km
- Population density within 500 km (including US populations)

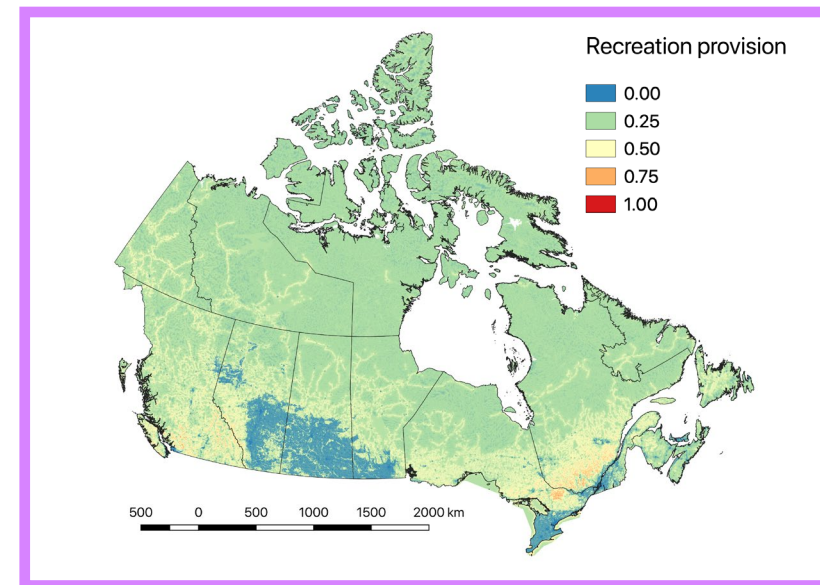
RECREATION: CAPACITY × ACCESS = PROVISION



X



=



Nature-based recreation provision

- Combination of capacity & access/demand
- Weighted towards areas with high capacity but low access/demand